Graduate Study and Research

in CIVIL ENGINEERING and SANITARY ENGINEERING

UNIVERSITY OF ILLINOIS **BULLETIN**

January, 1951

Foreword

This announcement contains extracts from the *Graduate College Bulletin* and other information pertaining to graduate study, fellowships, and research assistantships available to civil and sanitary engineering graduates who wish to pursue graduate study and research. Instruction and research in sanitary engineering as well as in civil engineering are administered by the Department of Civil Engineering, appropriate degrees being awarded in each field.

Information is included on the graduate courses offered by the Department of Theoretical and Applied Mechanics. Graduate courses in other departments are also available. Those which are usually of greatest interest to students in the Department of Civil Engineering are offered by the departments of Geology, Mathematics, Architecture, Chemistry, and Bacteriology.

The formal courses listed in this booklet cover the subject matter for which there is the greatest demand. Staff members and facilities are available to provide for individual study in fields not covered by these courses. Students may undertake special study or investigations by registering in C.E. 493, Special Problems. By making use of this provision, and by selecting a suitable thesis subject, extensive graduate study and research can be carried on in practically any phase of civil or sanitary engineering, whether or not it is treated in formal courses.

The information in the booklet is confined to matters of most general interest to graduate students. Additional information may be obtained from the Head of the Department of Civil Engineering, 201 Civil Engineering Hall, Urbana, Illinois. For a complete statement of the regulations of the Graduate College, students should consult the *Graduate College Bulletin*, copies of which may be obtained from the Graduate College, 109 Administration Building (East), Urbana.

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Nature of Graduate Work

The Department of Civil Engineering offers advanced study and professional training in the general fields of hydraulic engineering, municipal and sanitary engineering, soil mechanics and foundations, structural engineering, highway engineering, and railway engineering. Facilities for research are available in all these fields.

The degrees of Master of Science and Doctor of Philosophy may be attained by qualified students who satisfy the requirements of the Department and the Graduate College. Progress toward an advanced degree is measured not only by the accumulation of units of credit in formal course work but also by evidence of intellectual growth and achievement.

The principal aims of graduate study are the development of the power of independent work and the promotion of the spirit of research. Each candidate for a degree is expected to have a wide knowledge of his subject and of related fields of work. The graduate student is not expected to gain from lecture and laboratory courses all the knowledge and training necessary to meet the requirements for his degree.

Admission to the Graduate College

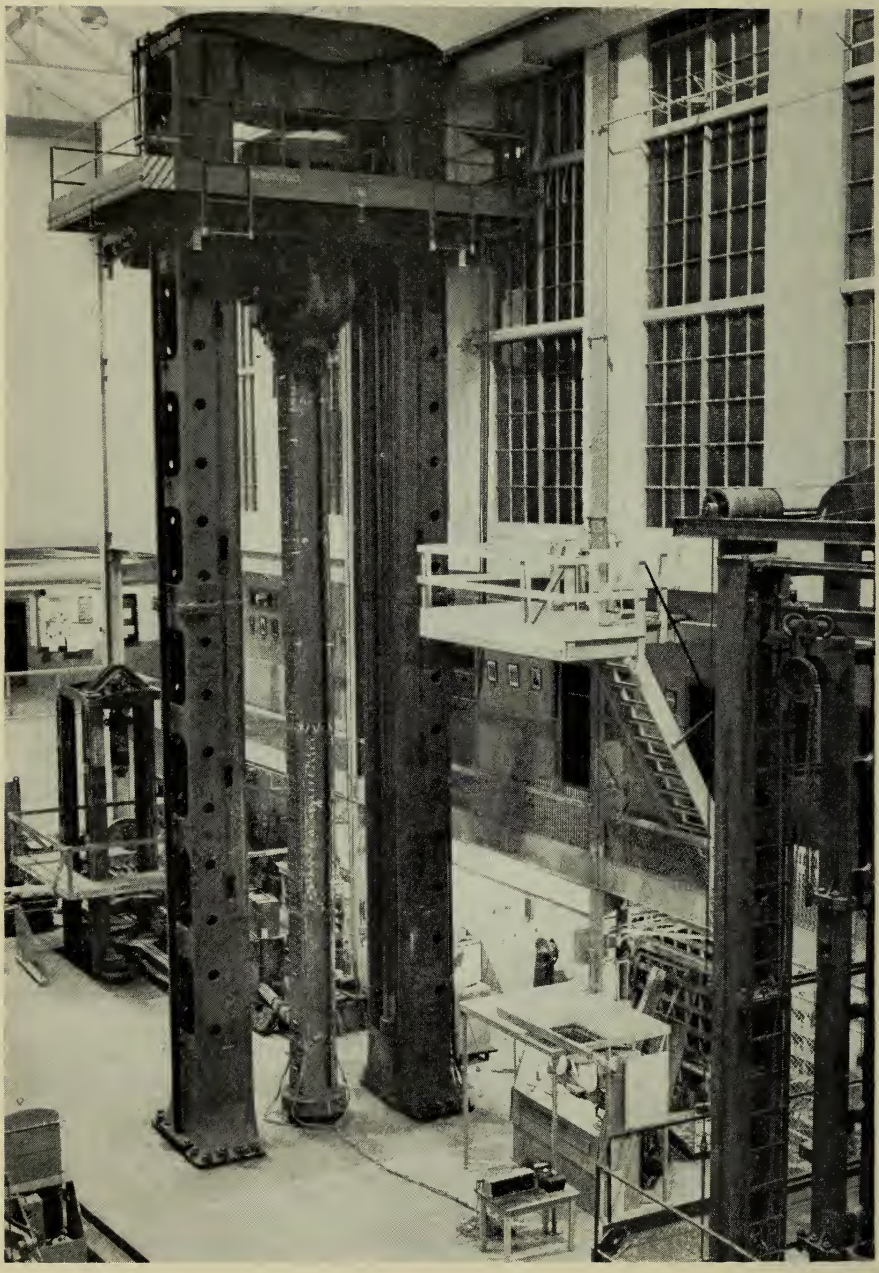
The general requirements governing admission to the Graduate College for study in this department are as follows.

(1) *Admission with Full Status.* Admission to the Graduate College is granted to graduates of institutions whose requirements for the degree of Bachelor of Science are substantially equivalent to those of the University of Illinois, provided that the applicant's undergraduate grade-point average for that portion of work which represents the last fifty per cent of the hours completed to secure the bachelor's degree, exclusive of the required physical education and military training, is at least 3.75,* and provided further that the undergraduate preparation is appropriate to advanced study in the chosen major field.

(2) *Admission with Advanced Standing.* Admission to the Graduate College is granted to those who hold bachelor's degrees and have completed one or more years of graduate study at accredited institutions and who desire to become candidates for the degree of Doctor of Philosophy at the University of Illinois, only upon the favorable recommendation of the department and of the Dean of the Graduate College. If admission is granted, the amount of credit to be allowed will be determined by the Dean upon the recommendation of the department.

Admission to graduate courses may be granted only to those who have had the requisite undergraduate work in those courses. Students whose preparation is considered inadequate may be required to take

* Based on a numerical equivalent of 5.0 for A, 4.0 for B, 3.0 for C, etc.



THREE MILLION POUND EMERY-TATNALL TESTING MACHINE IN THE CENTER BAY OF TALBOT LABORATORY

without credit certain undergraduate courses. But a student of mature age who satisfies the Dean of the Graduate College and the department concerned of his ability to pursue graduate work in a given line may be enrolled in particular graduate courses, without reference to a degree, and permitted to carry on such study or investigation under the direction of a department as the department shall recommend and the Dean approve.

Application blanks for admission may be obtained from the Director of Admissions and Records of the University. Every applicant must submit with his application for admission an official transcript of his college record.

Basis of Credit

Credit for graduate students is counted in *units*. A unit course requires approximately ten hours of time each week through one semester, irrespective of the distribution of that time in class work, laboratory or field work, and private study. Four such courses constitute a student's normal program for one semester. The maximum permissible program is five units.

A student who is employed can not expect to complete his academic work as promptly as he otherwise could do. The academic work carried by assistants and others on the University staff is limited by statute. Those employed outside the University are expected to reduce their programs of work in accordance with these regulations. The maximum amount of academic work is determined by the terms of employment as follows:

	Maximum Registration	
Nature of Appointment	*Semester*	*Summer Session*
Full time	1 unit	1 unit
Three-fourths time	2 units	1 unit
Two-thirds time	2¼ units	1 unit
Half time	3 units	2 units
One-third time	3½ units	2 units
One-fourth time	4 units	2 units

From the time of entrance upon graduate work at the University of Illinois, the work for a master's degree must be completed in not more than six calendar years, and that for a doctor's degree in not more than seven calendar years.

The Degree of Master of Science

Candidates for the degree of Master of Science are required to do at least one full year's work in residence, including a thesis. Four to five units constitute a normal semester program for the master's degree. A minimum of eight units must be completed for the degree. Only superior students are permitted to secure a degree with this minimum program.

Grades

Grades are recorded by the following letters: A, B, C, D, E. Any student who receives two units of grade below B must complete two additional units of A or B grade to qualify for the degree. Three units of a grade below B disqualify a student as a candidate for the master's degree. A grade of E in any course in the major field precludes the conferring of a degree in the academic year in which the failure was incurred.

Work Done Elsewhere

A graduate student who has done graduate work in other approved institutions may obtain credit not to exceed four units toward the master's degree by passing examinations in that work. Admission to such examinations requires the prior approval of the Dean of the Graduate College. Such a student may complete the work for the master's degree by completing additional units while registered in the Graduate College for at least two semesters.

If it is recommended in advance by the adviser, the Graduate College may permit a student to register for work at a laboratory elsewhere that offers facilities not available at Urbana, or in approved field work, with the understanding that such work will be accepted for graduate credit if completed satisfactorily. The adviser will examine the student's transcript or will examine the student directly when he returns to this campus and will then make a final recommendation to the Dean of the Graduate College concerning the credit to be given.

Majors and Minors

A candidate for a master's degree may do all his work in one field; or he may select a major and one minor, or a major and two minors. A major or minor denotes the field of knowledge of a department, or such part thereof as constitutes a separate and independent division of that field. For a master's degree, a major comprises work totaling a minimum of four units. Less than one unit of work will not satisfy the requirements for a minor.

Foreign Language

The ability to use one or more of the modern languages ordinarily studied in the undergraduate curriculum is desirable for candidates for the master's degree, but not required. A student who wishes to go beyond the master's degree to the doctorate should take at least one of the Graduate College language examinations during the first year of graduate study; no credit will be given toward the second year of the student's work for the doctorate until he has passed at least one language examination or its equivalent.

Master's Theses

The subject of a thesis for the master's degree must be filed at the Graduate College office *by the student during the registration period prior to his graduation.* A student usually devotes two units of work to his thesis, and no more than three units of thesis credit may be earned except by special permission.

The requirement of a thesis may be waived, on the recommendation of the adviser and with the approval of the Dean, *provided that application to waive the thesis is made at the time for announcing thesis subjects.* A student excused from writing must replace it with courses of instruction. In general, a student excused from writing a thesis will be required to earn a total of nine units of credit.

The Degree of Doctor of Philosophy

The degree of Doctor of Philosophy in Engineering is offered in certain lines of academic work, of a high scholastic type, in engineering science for students who wish to prepare themselves as experts, investigators, and teachers. The general requirements for this degree, as to preliminary education, languages, etc., are the same as in other subjects.

Residence Requirements

For the degree of Doctor of Philosophy, the student must spend, in resident study at an accredited educational institution, all three of the "years" required to obtain the degree; such "years" are defined as follows:

(1) *First Year.* The time required to complete eight units of graduate work with satisfactory grades in courses, and to pass one foreign language examination.

(2) *Second Year.* The time required to progress from the completion of the first year's work through the completion of the preliminary examination. This involves obtaining satisfactory grades in eight more units of graduate work, passing the second foreign language examination, and passing the preliminary examination.

(3) *Third Year.* The time spent between successful completion of the preliminary examination and the completion of all requirements for the doctor's degree.

A student who spends the first two years in residence at the University of Illinois may, by petition, request permission to spend the last year *in absentia.* A student who has completed the first year of graduate work elsewhere must be in residence during the two remaining years. In exceptional cases, a student with two years of graduate study

elsewhere, who satisfies his major department that he has completed work equivalent to the standard departmental requirements, will be permitted to take his preliminary examination, provided that he has fulfilled the language requirements. If he passes the preliminary examination, he may complete the requirements for the Doctor of Philosophy degree by devoting the third year to research in residence. Three units of grade below B disqualify a student as a candidate for a doctor's degree.

The registration for a full-time student shall be for not less than four nor more than five units; for a part-time student the registration shall ordinarily be on the basis of such fraction of four units as corresponds to the time given to study. It should be clearly understood, however, that for second-year students a mere accumulation of unit credits will not in itself entitle a student to the privilege of taking preliminary examinations, and that for third-year students such an accumulation of credits will not in itself entitle the student to admission to the final examination.

Major and Minor Subjects

A candidate for the degree of Doctor of Philosophy is required to pursue a major subject in the area of his research interest. He is also required to choose one or two minor subjects. If only one minor is chosen, it is called a "sole minor," and must be taken in an area other than that of the major. Credit for it must be earned by work representing not less than four units. If two minors are chosen, the first may be a subject closely related to the major. With the approval of the adviser, it may be a division of the major field of study; it must involve at least two units. In such a case, the second minor (not less than two units) must be taken in an area other than that of the major.

Language Examinations

The student will be required to demonstrate his ability to read French and German, and no student will be considered as beginning his second year of graduate study until he has passed the examination in at least one of these languages. Both language examinations must be passed before the student is admitted to the preliminary examination. The dates of the language examinations, and the dates when application for admission to these examinations must be made, are shown in the calendar in the *Graduate College Bulletin.*

Preliminary Examinations

A candidate for the doctor's degree must pass a preliminary examination intended to test his knowledge of his major and minor fields of study. He will not be admitted to this examination before (1) he has

passed the two required language examinations or their equivalent, (2) he has satisfactorily completed at least *sixteen units* of graduate work, and (3) his adviser and the head of the department of his minor field of study consider that he has adequate preparation in his major and minor fields. Upon the recommendation of the adviser, the Dean of the Graduate College will appoint the examining committee for the preliminary examination. This examination will be partly or entirely oral.

Thesis

The degree of Doctor of Philosophy is primarily a research degree; consequently the candidate is required to demonstrate his capacity for independent research by the production of an original thesis on some topic connected with his major field of study. The subject of the thesis should be chosen by the end of the second year and must be reported to the Graduate College office no later than six weeks after the beginning of the third year. The student should be registered in his thesis course for the number of units corresponding to the amount of time devoted to thesis research, four units being the equivalent of full-time work.

Final Examinations

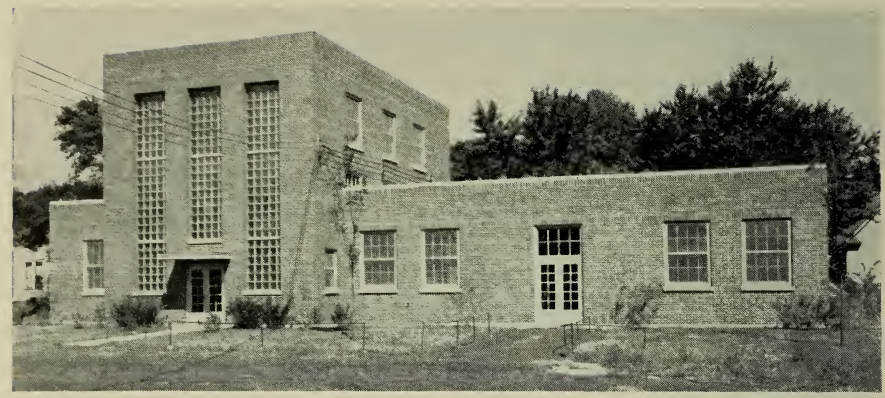
When the thesis has been completed, if the major adviser so recommends, the candidate will be given his final examination by a committee appointed by the Dean of the Graduate College. A student who, in the third year of study, fails to meet the expectations of the professors in charge of his work, or who in any way fails to maintain the standard of scholarship and power of research expected of him may be refused admission to the final examination.

The final examination must be completed at least two weeks before Commencement. This examination is concerned primarily with the research work of the student as embodied in his thesis, but may be much broader and extend over the candidate's whole field of study. The intention of the final examination is to verify that the candidate has a satisfactory grasp of his major subject as a whole, and a general acquaintance with the fields of knowledge represented by his course of study.

The final examination is oral and will be conducted entirely in the presence of the examining committee appointed by the Dean.

Other Examinations

Before the candidate is admitted to the final examination and the defense of his thesis, he may be required to take any other examination, oral or written, that is thought proper by the various departments in which he has studied. Such examinations are in addition to those regularly scheduled in the courses for which the student is registered.



SANITARY ENGINEERING LABORATORY

Buildings and Equipment

The teaching and research activities of the Department of Civil Engineering are conducted in large portions of two major buildings — Civil Engineering Hall and Talbot Laboratory — and completely occupy three smaller buildings — the Sanitary Engineering Laboratory, the Surveying Building, and the Hydraulic Engineering Laboratory.

Civil Engineering Hall. This building has a floor area of 64,000 square feet. It contains design rooms to provide tables for junior and senior civil and sanitary engineering students, and a similar room restricted to the use of graduate students. The Engineering Library, which has over 50,000 books, all significant engineering journals and periodicals, and reading rooms with a seating capacity of over 200, is housed in this building, and so is readily accessible to civil engineering students. About 50,000 of the less used engineering books are kept in the Main Library. The department offices are in Civil Engineering Hall.

Talbot Laboratory. The Talbot Laboratory is the outstanding building of its kind in the country. Its floor area of 82,000 square feet is shared by the Department of Civil Engineering and the Department of Theoretical and Applied Mechanics. It houses the following laboratories for testing, research, and instruction. The *structural laboratory* is in the large central crane bay, where testing machines varying in capacity from 30,000 pounds to 3,000,000 pounds are located. The latter machine has a vertical height sufficient to accommodate tension and compression specimens 38 feet long. Large machines for determining the fatigue strength of full-size structural members are important features of this laboratory. The laboratory is served by a traveling crane. The *concrete laboratory* is equipped for the study of proportioning and

mixing concrete and of its physical properties. The *highway materials laboratories* are equipped for tests and research in bituminous and non-bituminous highway materials. The *soils laboratories* are equipped to perform the various soil tests and provide excellent facilities for research. The *wood laboratory* is equipped for the various tests of wood specimens and for testing joint connected wood structures.

Also available for civil engineering research are a number of *computing machines* of various types for use in numerical methods of stress analysis and for the study of vibrations, buckling, and other problems. Electric desk calculators are located in computing laboratories in Talbot Laboratory and in Civil Engineering Hall. Use may be made of the IBM punched card tabulating and computing equipment in the Statistical Service Bureau. Use may also be made, under supervision, of the high-speed electronic digital computer which the University has built. This computer is one of the best of its type in the country, with a memory capacity of 1,024 numbers of 40 binary digits (13 decimal digits) and a multiplication speed of approximately 1,200 pairs of numbers per second.

Graduate students in civil engineering commonly elect courses which make use of the laboratories of the Department of Theoretical and Applied Mechanics which are also located in this building. The laboratories include the *hydraulics laboratory*, which is equipped with a standpipe, pumps, weirs, orifice tanks, turbines, long concrete channels, and other facilities for instruction and research in hydraulics; the *applied mechanics laboratory*, equipped with standard and special testing machines of various types and capacities; the *fatigue of metals laboratory*, equipped with a variety of machines for testing metals under fatigue loading; the *concrete research laboratory*, which is well equipped with testing machines, mixers, a concrete saw, a core drill, and other tools and equipment used in fabricating and testing members of plain and reinforced concrete and which is supplemented by the large crane bay and its testing machines; and several special laboratories, such as those for railroad rails, plastics, photoelastic investigations, and creep of metals.

Two well-equipped machine shops are provided for use in making and repairing equipment and apparatus for instruction and research.

Sanitary Engineering Laboratory. This building is modern in every respect and well equipped. It has a floor area of 5,000 square feet and provides classrooms, offices, and laboratories for instruction and research in sanitary engineering. Large tanks, ten feet in diameter, with various heights, are an important feature of this building. The tanks are intended mainly for the primary treatment of sewage in preparation for use in research, for the collection of fresh sludge and well-

digested sludge, and for the generation of gas through the digestion of sewage solids. Sewage is supplied by a connection with the main city outfall sewer adjacent to the building. Research in the purification of water, in the treatment of sewage and of industrial wastes, and in other branches of sanitary engineering requiring hydraulic, chemical, and biological equipment is being carried on in the Sanitary Engineering Laboratory. Opportunities to participate in the established projects and to pursue research independently on selected projects are offered.

The Surveying Building. This building is located near the surveying fields on the south campus. Its floor area of 9,400 square feet is divided among drafting rooms, classrooms, offices, and an instrument room which is well equipped with transits, levels, plane tables, and other instruments for plane and topographic surveying, precise levels and theodolites for geodetic surveying, and special instruments for aerial mapping.

Hydraulic Engineering Laboratory. The Hydraulic Engineering Laboratory occupies a space of approximately 10,000 square feet. It is provided with a pumping capacity of 2,500 gallons per minute at heads from 40 to 45 feet. Storage and sump facilities furnish 22,000 gallons. The piping arrangements are designed to permit operation of simultaneous experiments without interference.

Instrumentation is of the latest types. A unique feature of the laboratory is a heated space 10 feet wide and 330 feet long equipped with a traveling crane for the handling of heavy equipment. This space is well adapted to studies relating to either open channel or pipe flow.

Available within the laboratory are complete shop facilities for the construction of models, including apparatus for moulding plastic materials.

Cameras for both still and moving pictures are a part of the regular equipment. A darkroom permits the processing of photographs. Mechanical calculators are available for the analytical interpretation of experimental data.

Fellowships

A number of fellowships established by the Trustees of the University are open to candidates who are not over thirty years of age at the time when the appointment is to be made. To first-year graduate students of ability and promise there are open a number of fellowships of $700 and exemption from the payment of the usual tuition. Fellowships open to second-year and third-year graduate students

carry stipends of $850 and $1,000, respectively, and exemption from tuition. To be eligible for a $1,000 fellowship, an applicant must pass his language examinations before the date for filing applications and must be prepared to take the preliminary examination in his major and minor subjects by the following June.

Candidates for these fellowships must be graduates of the University of Illinois or of colleges or universities having equivalent requirements for bachelor's degrees.

Application must be made on blanks to be obtained from the Dean of the Graduate College. These application forms should be sent to the Dean of the Graduate College as early as possible in February of the academic year preceding that for which the fellowship is desired. No application will be considered if received later than February 15, until after April 15, the date when appointees from the first list of applications must accept or refuse their appointments.

Nominations to fellowships are made on the basis of worthiness of character, scholastic attainments, and promise of success in the principal line of study or research to which the candidate proposes to devote himself.

Research Assistantships in the Engineering Experiment Station

The Engineering Experiment Station is devoted to the study of problems of special importance to engineering and to the stimulation and elevation of engineering education. By undertaking a line of graduate study in close association with some one of the projects carried on in the Station, the student will come into contact with aspects of his specialty which he would rarely touch in a purely academic study, and will thus broaden his outlook. The Experiment Station makes available apparatus, equipment, and the services of machinists, which materially facilitate the carrying on of investigations.

Research assistantships, with a stipend of $1,200 for a college year of two semesters and exemption from tuition, are open to graduates of approved technical colleges and universities. Applicants to whom these assistantships are awarded agree to hold them for two college years, devoting one half of their time to the work of the Engineering Experiment Station. At the end of this period, if all requirements have been met, the degree of Master of Science will be conferred.

Appointments to research assistantships are made only to men with outstanding records or other excellent qualifications. Appointments

are given to first- and to second-year graduate students, but only rarely to third-year students who have not previously studied at Illinois. In general, with a half-time assistantship, two academic years of residence are required in order to obtain the master's degree.

A number of research assistantships in civil and sanitary engineering are available. They include assistantships established by the University, and others provided by cooperative research agreements with state and federal agencies, technical societies, and engineering associations. Fields of research which are now active include steel, concrete and wood structures, structural welding, soil mechanics, foundations, retaining walls, culverts, earth dams, highway pavements, hydraulic engineering, sanitary engineering, airports, and airplane structures. It is usually possible to assign a research assistant to a project in the field of his special interest. Often the research in which he is engaged will form the basis of his thesis, but his thesis is not restricted to this field.

Applications for research assistantships should be made to the Director of the Engineering Experiment Station not later than March 15.

Fees and Expenses

Tuition Fee

Residents of Illinois, except those holding scholarships, fellowships, and research assistantships, pay each semester a tuition fee of $40.00

Non-residents of Illinois, except those holding scholarships, fellowships, and research assistantships, pay each semester a tuition fee of 80.00

Hospital and Medical Service Fee. All students registering for resident work, except those who are on University appointment other than fellows and scholars or on appointment in allied surveys and laboratories on the Urbana campus, and those who are registered for not more than one unit of graduate work, pay each semester a hospital and medical service fee of 5.00

Laboratory, Library, and Supply Fee. Students taking more than two units of instruction pay each semester a laboratory, library, and supply fee of 8.00

Illini Union Service Charge. All students registering for resident work, except those who are members of the University staff and others who are registered for not more than one unit of graduate work, are assessed each semester an Illini Union service charge of 5.00

Holders of fellowships and assistantships are exempted from tuition fees; laboratory, library, and supply fee; and the Illini Union service charge.

Registration Dates

Registration for the first semester normally is held during the third week of September, and that for the second semester during the first week of February. A graduate student may enter at either time. Commencement normally is held during the second week in June, but degrees are also conferred in February.

PART OF THE HYDRAULIC ENGINEERING LABORATORY SHOWING A BRIDGE PIER EROSION MODEL

Courses in Civil Engineering and Sanitary Engineering

The prerequisite for graduate work in civil engineering and sanitary engineering is the equivalent of the undergraduate courses required for the degree of Bachelor of Science in the branch of the subject in which registration is desired.

Courses for Graduates

401. Geodetic Engineering. Principles and practice of precise triangulation, traverse, and levels. I; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering. Schmidt.

402. Geodetic Engineering. Astronomic determination of latitude, longitude, and azimuth. Systems of plane coordinates. Map projections. Electronic and special control surveys. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering. Schmidt.

420. Highway Engineering. Highway construction, street layout, regional plans, and pavements for cities. I; 1 unit. Prerequisite: Civil Engineering 220. Crandell.

422. Municipal Engineering. City finances and budgets, work of the city engineer, city manager, zoning, playgrounds and parks, street cleaning, smoke prevention, fire prevention. II; 1 unit. Prerequisite: Civil Engineering 220. Crandell.

423. Highway Traffic, Transport, and Safety. Traffic growth, characteristics, surveys, regulations, and signaling; private and commercial transportation by automobile, bus, and truck; transport organization and regulation; accident surveys, analysis, and prevention. I, II; 1 unit. Prerequisite: Civil Engineering 223, or equivalent. Wiley.

424. Airport Design. Selection of site, soil investigation, layout, drainage, runway design and construction, hangars and other structures, and other civil engineering features of airport design and construction. I, II; 1 unit. Prerequisite: Graduate standing in civil engineering. Reickert.

425. Railway Location and Operation. Railway location; track capacity; tonnage ratings; train scheduling. I; 1 unit. Prerequisite: Civil Engineering 203, 226, or equivalent experience, or consent of instructor. Hay.

426. Railway Location and Operation. Continuation of Civil Engineering 425. Additional problems in railway location and maintenance; design of yards, turnouts, and passenger stations; economics of maintenance; railway labor. II; 1 unit. Prerequisite: Civil Engineering 425, or equivalent, or consent of instructor. Hay.

440. Water Supply. Design, pumping machinery, administration, and operation. I; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering, or equivalent. Babbitt.

443. Sewerage. Sewer design, construction, maintenance, operation, and financing. II; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering, or equivalent. Babbitt.

444. Sewage Disposal, Wastes Disposal, and General Sanitation. Principles and design of sewage treatment and waste disposal works. II; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering, or equivalent. Babbitt.

446. Water Purification and General Sanitation. Design of water purification works and principles of sanitation. I; 1 unit. Prerequisite: Bachelor of Science degree in sanitary engineering, or equivalent. Babbitt.

448. Sanitary Engineering. Laboratory. Tests of water supply; sewerage; water purification and sewage treatment equipment and processes. I, II; 1 to 2 units. Babbitt.

450. Hydrology and Flood Control. Magnitude and frequency of flood flow of streams, minimum flow of streams, and regulation of flow by storage reservoirs; intense rainfall and the development of intensity curves for use in rational run-off formula; unit-graph method of computing flood run-off; flood control and prevention by channel improvement, levees, and reservoirs. I, II; 1 unit. Prerequisite: Civil Engineering 250 and 351, or equivalent. Doland.

452. Water Resources Planning and Development. Purposes and techniques of planning water resources developments; methods of evaluating the engineering and economic aspects of water conservation projects developed through the examination of actual proposals. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering or consent of instructor. Doland.

455. Water Power Engineering. Preliminary investigations, selection of site, storage requirements, structures, machinery, etc. I, II; 1 unit. Prerequisite: Civil Engineering 255, or equivalent. Doland.

457. Hydraulic Engineering Laboratory. Design, construction, and testing of individual or semi-individual laboratory studies. Study and discussion of advanced subjects of hydraulic engineering phenomena. I; 1 to 2 units. Prerequisite: Bachelor of Science degree in civil engineering, or consent of instructor.

458. Open Channel Flow. Special transitions, structures, and analysis of existing methods of computation. Theory of supercritical velocity flow. II; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering, or consent of instructor. Doland.

460. Advanced Structural Analysis. Basic theory of indeterminate structures; deflections and displacements; continuous beams and frames; virtual work; qualitative and quantitative influence lines. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering and undergraduate course in theory of simple structures. Vawter.

461. Structural Theory and Design. General theory of continuity; moment distribution; the column analogy; rigid frame bridges and buildings; fixed and continuous arches; classification of structures from viewpoint of design. I, II;

1 to 2 units. Prerequisite: Bachelor of Science degree in civil engineering with a basic course in indeterminate structures. Shedd, Vawter.

462. Structural Theory and Design. Statically indeterminate trusses; continuous trusses; steel arches; secondary stresses; suspension bridges; long-span roofs; skeleton steel buildings. I, II; 1 to 2 units. Prerequisite: Bachelor of Science degree in civil engineering with a fundamental course in indeterminate structures. Shedd, Vawter.

464. Reinforced Concrete Design. Theories of action of beams, slabs, and columns of reinforced concrete; codes and specifications and their influence on design; effect of continuity. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with undergraduate courses in structures. Reickert, Shedd.

465. Steel Design. Design of steel members; codes and specifications for buildings; riveted and welded connections; evolution of bridge specifications; loads and working stresses; economic proportions. I, II; 1 unit. Prerequisite: Bachelor of Science degree in engineering with undergraduate courses in structures. Shedd.

466. Investigations in Reinforced Concrete Members. Behavior of reinforced concrete structural members. Critical reviews of experimental and analytical investigations. Beams and columns, subjected to flexure, axial compression, combined axial compression and flexure, and combined flexure and shear. I; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering with undergraduate courses in structures and reinforced concrete design. Siess.

467. Investigations in Reinforced Concrete Structures. Behavior of reinforced concrete structures. Critical reviews of experimental and analytical investigations. Statically indeterminate reinforced concrete structures: frames, floor slabs, column footings, highway bridge floors. II; 1 unit. Prerequisite: Civil Engineering 466, or consent of instructor. Siess.

469. Wood Structures. Theory and practice in the design of modern wood structures; the effect of the plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the development of design formulas. I, II; 1 unit. Oliver.

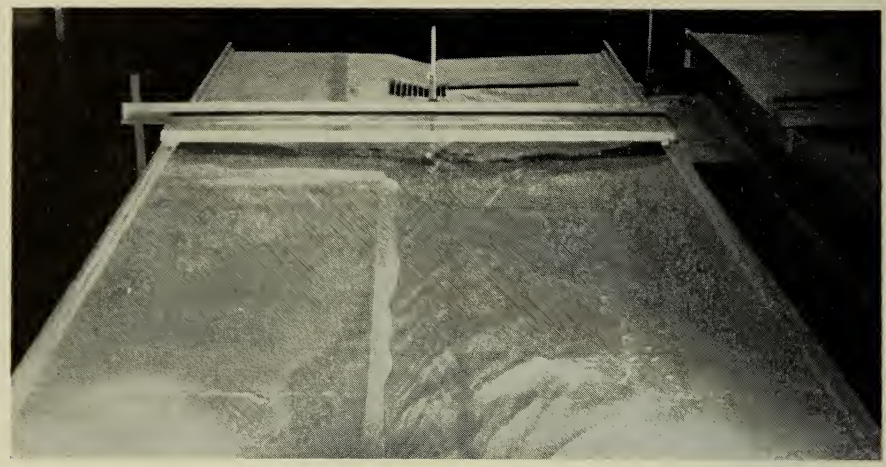
470. Earth Pressures and Retaining Walls. A study of earth pressures considering the significant properties of soils; methods of computing earth pressures and the limitations in their dependability; stability computations; and the design and construction of retaining walls and abutments. I; 1 unit. Prerequisite: Bachelor of Science degree in civil engineering. Huntington.

471. Earth and Masonry Dams. Stability of rolled-fill and hydraulic-fill earth dams and rock-filled dams; methods of construction; seepage losses; control of seepage forces; safety of foundation. Solid gravity, arched gravity, arch, multiple arch and slab and buttress dams; safety against sliding and overturning; unit stresses on horizontal sections and principal stresses; joints; drainage; foundations. II; 1 unit. Huntington, Peck.

473. Soil Mechanics. Physical properties of soils; identification and description of soils; permeability, compressibility, consolidation, and shearing resistance; deformation and drainage characteristics. Theories of soil mechanics; earth pressure, stability, settlement, seepage, and consolidation. I; 1 unit. Peck.

474. Soil Mechanics. Practical considerations, boring, sampling, testing; retaining walls, open cuts, slides, dams, and embankments; foundations, settlements due to excavation and other causes; field observations. Limitations and alternatives to conventional procedures of design and construction. II; 1 unit. Prerequisite: Civil Engineering 473. Peck.

481. Numerical and Approximate Methods of Structural Analysis. Methods of successive approximations, and numerical procedures, for the solution of complex problems, with applications to bridges, buildings, and aircraft structures. Method of successive relaxation of constraints, energy methods, difference



MODEL FOR STUDY OF OVERBANK INTERCEPTION (PART OF A COOPERATIVE STUDY WITH THE ILLINOIS HIGHWAY DEPARTMENT)

equations, numerical integration procedures, method of collocation, method of least squares, and Galerkin's method. I or II; 1 to 2 units. NEWMARK.

482. BUCKLING, VIBRATIONS, AND IMPACT. Elastic and inelastic instability of bars, plates, and plates with stiffeners; vibrations of structures including earthquake effects; action of simple structural elements and of more complex structures subjected to dynamic loads, with applications to bridges, buildings, and aircraft structures. I or II; 1 to 2 units. NEWMARK.

483. ANALYSIS AND DESIGN OF PLATES AND SLABS. Fundamental theory of bending and buckling of plates, including stiffened plates; practical application of theories in analysis and design of reinforced concrete bridge and building floors, highway and airport pavements, and structural plate components in metal. I; 1 to 2 units. Prerequisite: Consent of instructor. NEWMARK.

484. BEHAVIOR OF STRUCTURES UNDER DYNAMIC LOADS. Analysis of the effects of wind load, earth tremors, impact, and explosion blast on buildings and bridges; vibrations of and impacts on structural components, with particular emphasis on beams, slabs, and columns; propagation of stress waves in steel and concrete; effects of damping and inelastic action; self-excited vibrations with application to cables and suspension bridges. II; 1 unit. Prerequisite: Civil Engineering 461, or equivalent. NEWMARK.

485. ANALYTICAL STUDY OF TESTS OF STRUCTURAL MEMBERS. Planning tests, limitations of experimental methods, interpretation of results in terms of design practice. II; 1 unit.

486. DESIGN OF LIGHTWEIGHT STRUCTURES. Analysis and design of structures and structural members of minimum weight. I, II; 1 to 2 units. Prerequisite: Previous work in statically indeterminate structures. CLARK.

491. THESIS (M.S. and Ph.D.) I, II; ½ to 4 units.

493. SPECIAL PROBLEMS. Individual investigations or studies of any phase of civil engineering selected by the student. I, II; ½ to 2 units.

Courses for Graduates and Advanced Undergraduates

332. ENGINEERING PROPERTIES OF SOILS. Laboratory practice in the testing, classification, and identification of soils; engineering soil surveys and explorations; and sampling. I, II; ½ unit. Prerequisite: Consent of instructor. BAUER.

344. Water and Sewage Treatment. Principles, design, and operation of water purification and sewage treatment works. I; 1 unit. Prerequisite: Credit or registration in Bacteriology 104 and Civil Engineering 240 or 241. Babbitt, Dietz.

345. Public Health Engineering. Principles of sanitation, waste collections, and disposal; sanitary regulations, biostatistics. II; ½ unit. Prerequisite: Credit or registration in Bacteriology 104 and Chemistry 122. Babbitt.

351. Drainage and Flood Control. Land drainage, river improvement, flood control. II; ½ unit. Prerequisite: Civil Engineering 250. Doland.

356. Hydraulic Engineering Laboratory. Fundamental principles, operation and use of model laboratories, dimensional analysis, hydraulic similitude, theory and design of hydraulic models. II; ¾ unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. Guillou.

359. River Hydraulics. Gaging of streams, stream erosion and deposition, use of groins, revetments and mats, stream systems, and river navigation. I; ¾ unit. Prerequisite: Theoretical and Applied Mechanics 232. Doland.

361. Statically Indeterminate Structures. Elastic theory and its applications to statically indeterminate structures. I, II; ½ unit. Prerequisite: Civil Engineering 262; credit or registration in Civil Engineering 264. Clark, Oliver.

362. Statically Indeterminate Structures. I, II; ½ unit. Prerequisite: Civil Engineering 361, or 262 and consent of instructor. Clark, Vawter.

373. Introduction to Soil Mechanics. Investigation of engineering characteristics of subsurface conditions; principal theories of soil mechanics; application to design of retaining walls, open cuts, drainage systems, and stability of slopes. I; 1 unit. Prerequisite: Credit or registration in Civil Engineering 270, or consent of instructor. Peck.

374. Applied Soil Mechanics. Application of soil mechanics to foundations of buildings, compaction of embankments, and construction of culverts and tunnels. II; 1 unit. Prerequisite: Credit or registration in Civil Engineering 270, or consent of instructor. Peck.

375. Engineering Aspects of Surficial Soils. Use of geologic, pedologic, and air-photo information for identification and evaluation of the engineering properties of surficial soils. II; 1 unit. Prerequisite: Civil Engineering 230, or consent of instructor. Thornburn.

Courses in Theoretical and Applied Mechanics

Courses for Graduates

421. Mechanics of Materials. Methods of obtaining relation between loads and stresses and strains in various members. The main topics covered in this course and the one which follows are: curved beams, unsymmetrical bending, thick-walled cylinders, beams on elastic supports, contact stresses, torsion of members with non-circular cross-section, stress concentrations, elastic energy methods applied to statically indeterminate members, flat plates, inelastic behavior of various types of members. Introduction to mathematical theory of elasticity; elastic and plastic buckling; criteria of failure by yielding and by fracture. I; ½ to 1 unit. Smith.

422. Mechanics of Materials. Continuation of Theoretical and Applied Mechanics 421. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 421. Smith.

424. Properties of Engineering Materials. Significance of properties under various conditions of loading and use, including static, creep and fatigue, and impact properties; tests and interpretation of test data. Methods of obtaining special combinations of properties. Effects of temperature, strain rate, internal structure, etc. Specifications of properties and materials: II; ½ to 1 unit. Collins.

427. Analytical Study of Experimental Work in Reinforced Concrete. A critical study of available results of tests of reinforced concrete members and

structures, with particular attention to beams, frames and footings. I; 1 unit. Prerequisite: Introductory course in reinforced concrete.

428. Analytical Study of Experimental Work in Reinforced Concrete. Continuation of Theoretical and Applied Mechanics 427, with particular attention to columns and slabs. II; 1 unit. Prerequisite: Introductory course in reinforced concrete.

431. Applied Fluid Mechanics. A course designed to illustrate applications of dimensional analysis, the energy principle, and the momentum principle in practical analyses of flow problems. Dimensional analysis is developed systematically. It is employed to develop model laws, the von Karman theory of uni-directional turbulent flow, the correlation between the Chezy formula and the Darcy formula, and other topics. The energy principle is applied to problems of transient flow, the theory of gravity waves, and flow in open channels. The momentum principle is applied to the theory of open-channel flow, the theory of the hydraulic jump and the plane shock, and the theory of the boundary layer. I; 1 unit. Prerequisite: Theoretical and Applied Mechanics 232 or equivalent. Langhaar.

432. Theory of Flow of Incompressible Fluids. A course emphasizing topics in classical fluid mechanics which are the basis of many modern developments. The material consists of fundamentals of frictionless flow, Euler's differential equations of motion, velocity potentials, stream functions, sources and sinks, complex potential functions, conformal mapping, Blasius' theorems of lift and moments, vortex motion line, vortices and vortex sheets, stresses in viscous fluids, Navier-Stokes equations, and differential equations of the boundary layer. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 232 or equivalent. Langhaar.

451. Theory of Elasticity with Application to Engineering Problems. A study of the mechanics of elastic deformable bodies, based on the fundamental concepts of equilibrium, geometry of strain and properties of materials. Relations between stresses, strains, and displacements are studied in detail with special consideration given to their significance in engineering problems. I; 1 unit. Myklestad.

452. Theory of Elasticity with Application to Engineering Problems. Continuation of Theoretical and Applied Mechanics 451. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. Myklestad.

461. Inelastic Behavior of Engineering Materials. An outline of a general theory of inelastic behavior. A study of the mechanisms of inelastic action involving viscosity, plasticity, and fracture in relation to yielding or flow, creep, fracture under repeated loads and under impact. Relation of inelastic behavior to planning of tests, to the interpretation of test results and to design. I; ½ to 1 unit. Prerequisite: One year of graduate work. Smith.

462. Inelastic Behavior of Engineering Materials. Continuation of Theoretical and Applied Mechanics 461. II; 1 unit. Prerequisite: Theoretical and Applied Mechanics 461. Smith.

491. Thesis. I; 1 to 2½ units. Staff.

492. Thesis. II; 1 to 2½ units. Staff.

493. Special Problems. Individual investigation of studies, either analytical or experimental, in one or more phases of theoretical and applied mechanics, including mechanics of materials, theory of elasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, etc. I; ½ to 2 units. Staff.

494. Special Problems. Individual investigation of studies, either analytical or experimental, in one or more phases of theoretical and applied mechanics, including mechanics of materials, theory of elasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, etc. II; ½ to 2 units. Staff.

Courses for Graduates and Advanced Undergraduates

311. Mechanical Vibrations. Kinematics of vibratory motion. Comprehensive study of motion having single degree of freedom. Critical speeds of shafts; vibration of systems with several degrees of freedom. Applications to engineering problems. I; 3 hours, or ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 154 or 156 or 211 and 221. Jones, Myklestad.

312. Mechanical Vibrations. Continuation of Theoretical and Applied Mechanics 311. Problems in bending and torsional vibrations. Special problems. II; 3 hours, or ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 311. Myklestad.

321. Advanced Mechanics of Materials. Methods used in elementary mechanics of materials are expanded and generalized and used to solve more complex problems. Thick-walled cylinders, torsion of bar having non-circular cross-section; curved beams, unsymmetrical bending, flat plates; theories of failure. I; 3 hours, or ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223. Black, Smith.

323. Advanced Laboratory in Materials Testing. Calibration of testing machines and of strain measuring instruments. Use of various mechanical and electrical strain gages. Interpretation of test results. Relation of tests to specifications of materials. I, II; 3 hours, or ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223. Collins, Putnam.

326. Experimental Stress Analysis. Methods of extending and applying basic physical laws to the measurement of stresses or deformations that are of significance in the engineering design of load resisting members. Systematic applications of optical, electrical, and physical properties of matter to the instrumentation and measurement of model or prototype stresses. Among the topics studied are: Photoelasticity, significant mechanical characteristics of materials, accuracy vs. sensitivity of measurement, dynamometers, and strain measuring devices, measurement of vibration stresses, models and analogies, brittle coatings, electrical resistance gages, etc. I, II; 3 hours, or ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 150, 211, 221, and 223 (321 desirable). Dolan.

334. Fluid Mechanics and Advanced Hydraulics. A study of the basic properties of fluids in general, particularly those that influence the flow of fluids in pipes and open channels, viscosimetry, dimensional analysis, effect of boundary conditions, cavitation, water tunnel, hydraulic pump, water hammer, pumps, turbines. Some laboratory work. II; 3 hours, or ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 232 and 234. Lansford.

351. Engineering Analysis. Analytical, graphical, and approximate methods of solving equations common to engineering; curve fitting and empirical formulas; applications of infinite series, especially Fourier series, vector analysis, statistical analysis, etc. I; 3 hours, or ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 154 or 156 or 211 and 221. Myklestad.

352. Engineering Analysis. Continuation of Theoretical and Applied Mechanics 351. II; 3 hours, or ½ to 1 unit. Myklestad.